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GROWING AND PLANTING HARDWOOD SEEDLINGS

on the
FARM



FOREST TREES grown on the farm add to its value and beauty. They supply material for farm use, such as poles, posts, and cordwood; and they afford shelter for live stock, and protect crops and buildings from the hot winds of summer and the cold winds of winter. Moreover, they can often be grown successfully on soils too poor or on slopes too steep for the successful production of the ordinary agricultural crops.

It is the purpose of this publication to point out simple methods which may be followed in planting and caring for hardwood trees on the farm and in collecting, extracting, and storing the seed of the common hardwood trees of the United States and in growing the young trees in a home garden or nursery.

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GROWING AND PLANTING HARDWOOD SEEDLINGS ON THE FARM.

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WHAT TREES TO GROW.

IN DECIDING on the species of hardwood trees to be grown on the farm, one should keep in mind, first, the object of growing the trees, and, second, their adaptability to the climate of the region and to the situation in which they are to be planted. To illustrate: The boxelder is not a good tree to plant for lumber; yellow poplar, because of climatic conditions, can not be grown successfully in the plains region of the central United States; and hardy catalpa will not thrive on poor sandy or heavy clay soils. To a certain extent trees may be grouped as those most valuable for lumber, for posts and poles, for windbreaks, etc. An attempt has been made in Table 1 to group the hardwood trees according to their suitability for such uses. The second consideration is very important. Too often prospective planters are dazzled by tales of trees that will thrive on any and all soils, that will grow with extreme rapidity, that are imperishable when set out as posts, or that are much more valuable than other species for lumber. It is usually safe to assume that such reports have little foundation in fact. *The best trees for planting on the home farm are usually those that grow naturally on similar soils in the region or those that have been tried out by the neighbors and have been proved a success.* Many plantations have turned out to be failures, with resulting disappointment to their owners, because of the selection of trees unsuited either to the climate or to the soil of the planting site.

NOTE.—This bulletin does not represent original work by the writer. The information it contains has been compiled from numerous sources. The writer is indebted especially to Prof. J. S. Illick, of the Pennsylvania department of forestry, for considerable information and many helpful suggestions.

TABLE 1.—*Hardwood trees most valuable for various purposes.*

Lumber.	Handle stocks.	Excelsior.	Railroad ties and round mine timbers.	Cooperage stock.
Ash.	Ash.	Aspen.	Black locust.	Ash.
Basswood.	Beech.	Basswood.	Honey locust.	Basswood.
Beech.	Birch.	Cottonwood.	Red oaks.	Beech.
Birch.	Hickory.	Willow.	White oaks.	Birch.
Black cherry.	Sugar maple.	Yellow poplar.		White elm.
Cottonwood.	White oaks.			Sugar maple.
Cucumber.				White oaks.
White elm.				Red gum.
Hickory.				
Sugar maple.				
Red oaks.				
White oaks.				
Red gum.				
Sycamore.				
Black walnut.				
Yellow poplar.				

Veneer logs.	Poles and posts.	Hardwood distillation.	Windbreaks.
Basswood.	Hardy catalpa.	Beech.	Green ash.
Beech.	Coffee tree.	Black birch.	Boxelder.
Yellow birch.	Red elm.	Yellow birch.	Cottonwood.
Black cherry.	Eucalypts.	Sugar maple.	Eucalypts.
Sugar maple.	Black locust.		Hackberry.
Oaks.	Honey locust.		Silver maple.
Red gum.	Russian mulberry.		Russian mulberry.
Sycamore.	Oaks.		Osage orange.
Black walnut.	Osage orange.		Russian olive.
Yellow poplar.	White willow.		White willow.
			Yellow willow.

The planter will doubtless be influenced in his choice of species by their rates of growth. Tables 2 and 3 show this approximately for the kinds of trees for which growth figures are available. The rates indicated may be too low for some trees in some regions, but it is believed that the tables are reliable for purposes of comparison.

TABLE 2.—*Average diameter growth of hardwood trees.*

Average number of years required to grow each inch in diameter.	Species.
½ to 3 years.....	* Eucalypts.
2 to 4 years.....	* Cottonwood, black willow, * white willow, * honey locust, * black locust.
3 to 6 years.....	Red gum, * silver maple, *white elm, * Russian mulberry, yellow poplar, chestnut, * hardy catalpa.
4 to 7 years.....	* White ash, * green ash, * boxelder, * black walnut, * butternut, red oak, black oak, * bur oak, aspen, * osage orange, basswood.
5 to 10 years.....	Hickory, white oak, chestnut oak, paper birch, *hard maple, yellow birch, beech.

The table is based upon the growth of trees both in plantations (those starred) and in natural forest (those not starred). In plantations more rapid growth can often be secured, particularly of the trees named in the last line.

TABLE 3.—*Height growth of hardwood forest trees produced from seed.*

[Average height.]

Species.	At 10 years.	At 20 years.	At 30 years.	At 50 years.
Green ash	26	41	52	70
White ash	19-25	34-50	45-67	62-83
Aspen	8-21	17-40	28-55	50-75
Basswood		16-32	23-44	37-63
Beech		8-19	13-28	22-42
Paper birch	13	30	44	62
Yellow birch		*-30	8-39	15-54
Boxelder ²	20			
Hardy catalpa ²	19	27	33	
Chestnut	7	17	33	64
Cottonwood ³	56	97	115	136
White elm		21	28	40
Eucalyptus ² (blue gum)	24-80	70-90	85-160	
Shagbark hickory	3-7	8-18	15-32	32-51
Black locust	15-20	28-45		44-65
Honey locust ²	18	27	35	
Silver maple ²	22	44	60	80
Sugar maple		*-18	*-29	10-48
Bur oak ²			40	60
Red oak	13	32	46	72
White oak	11-12	22-25	32-38	53-63
Osage orange ²		15-25	37	
Red gum	35	66	88	108
Black walnut ²	18	30	40	60
Black willow ³	50	73	89	109
White willow ²	15-24	35-50		
Yellow poplar	20-27	36-50	50-64	78-83

¹Data not available.

¹ The slower growth in each case is on poor situations; the more rapid growth, on better situations. Where only one figure is shown, it represents approximately the average growth on all situations where measurements have been recorded. In plantations, the height growth should equal and often exceed the faster rate of growth indicated by the table.

²Growth in plantations on farm lands.³Measurements made on trees in the lower Mississippi Valley where growth is very rapid.

PLANTING TWO OR MORE KINDS OF TREES TOGETHER.

A mixture of two or more kinds of trees in a plantation may sometimes be desirable, although it is not ordinarily recommended. For their best development, some trees, such as cottonwood, should be spaced widely in a plantation; others, such as black walnut and black locust, have such scant foliage that their shade does not prevent the growth of a heavy sod of grass. In both of these cases, a mixture will more completely utilize the area planted, increasing the yield and bringing about better forest conditions in the plantation.

Mixtures may be desirable for other reasons. Planting stock of one species alone may be expensive; and if a less valuable tree, or filler, to be cut out when the trees begin to crowd, is mixed with the main crop, it will keep down the first cost. If a species to be planted is liable to serious diseases or insect attack, as are chestnut and black locust, the planting in mixture with another kind of tree not liable to such attack will provide for a stand of trees in case the chestnut or locust is killed.

The following list gives a number of hardwood mixtures which should prove successful on soils and in regions adapted to both species. It can not be stated with assurance that these mixtures will produce a satisfactory stand, because experience with them has

not been sufficient to serve as a strict guide. Ordinarily, plantings of one species only are more satisfactory:

Hardwood mixtures for planting.

Cottonwood and silver maple.	Black locust and boxelder.
Cottonwood and green ash.	Black locust and hickory.
Honey locust and hackberry.	Yellow poplar and white oak.
Honey locust and green ash.	Yellow poplar and hard maple.
White elm and hackberry.	Yellow poplar and hickory.
White elm and green ash.	Red gum and white oak.
White elm and white ash.	Red gum and hickory.
Black walnut and green ash.	Red gum and beech.
Black walnut and hackberry.	Green or white ash and hackberry.
Black walnut and hickory.	Green or white ash and hickory.
Black walnut and white oak.	Red oak and basswood.
Black walnut and white ash.	Red oak and white oak.
Black locust and yellow poplar.	Red oak and hard maple.
Black locust and white oak.	Red oak and hickory.

LOCATION OF PLANTATION OR WINDBREAK.

Generally speaking, unless intended for windbreaks, plantations should be located on the poorest soil of the farm, that least suited to

the production of agricultural crops. Hillsides and poorly drained or rocky or sandy situations should be selected, if there are such. Corners of the farm cut off by a stream or railroad may be chosen. If there are no such situations on the farm, the plantation should be located near the buildings, where it will not only be convenient but will serve as a windbreak.



FIG. 1.—Red oak and chestnut plantation. Strafford County, N. H.

yards against which the prevailing winter winds blow. If a narrow windbreak of only a few rows is planted, it should be several rods away

Windbreaks for protection of the home and buildings should be located on that side of the buildings and the stock-feeding

from the building or yard. Snow drifts under the lee of such a wind-break and lies deep around buildings or a feed lot close to it. This drifting may be partially prevented by planting two such narrow windbreaks parallel to each other and about two rods apart. Snow will then drift into and for the most part be held in this intervening space.

Windbreaks for crop protection should be located so as to protect the crop from the most damaging winds, usually summer winds. As efficient windbreaks exert their protective influence along the surface to a distance of from fifteen to twenty times their height, the intervals between them should be about fifteen or twenty times the height of the trees at their maturity.

ESTABLISHMENT OF PLANTATION.

PLANTING OF STOCK.

In starting a grove, the planter ordinarily has the choice of using seedlings, seed, or cuttings. Seedlings 1 or 2 years old are preferable in the great majority of cases. They are fairly cheap and have the best chance of succeeding.

Nut trees, such as walnut, hickory, and oak, develop a very deep taproot and few lateral feeding roots during their first year. They can not ordinarily be transplanted to the field so successfully as other trees, so that planting the nuts or acorns on the permanent site is usually considered preferable. Black walnut plantations have been successfully started by the use of sprouted nuts. It would seem that the same method might be followed with other nut trees.

Cottonwood and willow plantations are most easily started with cuttings. These are simply from 12 to 14-inch sections taken from



FIG. 2.—Shellbark hickory plantation, 27 years old. Champaign County, Ill.

the 1 or 2 year old twigs of living trees. The cuts should be made with a sharp tool, to avoid bruising the bark. Cuttings should be collected during early winter and buried in moist sand in a cool place until the time for planting.

PREPARATION OF SOIL.

The necessity of soil preparation will depend somewhat on the region. On the prairies or in other regions where tree growth does not naturally thrive, the area should be plowed, preferably in the fall. In regions where trees naturally thrive, such preparation, is also decidedly beneficial although not always necessary. *Heavy*



FIG. 3.—Soft maple plantation. Trees 5 to 13 inches in diameter. Jefferson County, Iowa.

sod land in any region should not be planted until it has been plowed and cropped for two or three years.

METHODS OF PLANTING AND SOWING.

SLIT.

In the slit method a wedge-shaped hole is opened in the ground by inserting a spade or mattock and moving it backward and forward. The root of the tree, or the cutting, is then inserted back of the tool in the cleft thus formed, the tool is removed, and the earth is pressed with the foot firmly around the plant. If the root systems are not overlarge, this method may generally be used with success in light soil that is free from rocks.

INDIVIDUAL HOLES.

If the soil is heavy or rocky, or if the trees have large root systems, the best method is simply to dig a hole for each individual tree, pull

the soil in over the roots, and tamp it thoroughly. This is undoubtedly the surest method for trees of large size.

PLANTING SPROUTED NUTS.

A simple and successful method of planting black walnut was discovered by a farmer in Indiana. It should be equally successful, it seems, with the oaks, hickories, butternut, or any other hardwood species which develop pronounced taproots and in consequence can not be very successfully transplanted from the nursery to the field. This farmer buried the walnuts in a shallow pit where they were subjected throughout the winter to the action of moisture and frost.



FIG. 4.—Cottonwood and green ash windbreak. Butler County, Nebr.

With the advent of warm spring weather, the nuts began to sprout. He planted the sprouted nuts on well-tilled land by scooping out a little soil with his hands, placing the nuts in the holes thus formed, and covering them lightly. In following this plan there are several precautions which should be taken: (1) The pit in which the nuts are stored should be located in a well-drained, shaded spot; (2) the nuts should be protected against destruction by rodents; and (3) they should be examined frequently in the spring so that there will be no delay in setting them out shortly after sprouting commences.

FURROW.

The young trees or seeds may be planted in a plowed furrow. This is a rapid method and usually quite successful. It is especially suitable for planting cottonwood and willow cuttings. Seedlings are set

in the bottom of the furrow, and loose earth is pulled around the roots and tamped firmly. Cuttings are set in the furrow with the lower ends down in a slanting position. About 1 or 2 inches of the cuttings should be left extending above the surface of the ground. Soil is then pulled in and trampled firmly about them. Seeds are dropped in the furrow, several in a spot at regular intervals, and covered with 1 or 2 inches of soil.

SEED SPOT.

In the seed-spot method seed are sown directly on the planting site in spots at regular intervals. The ground in these spots is usually



FIG. 5.—Green ash plantation, 40 years old. Champaign County, Ill.

stirred somewhat with a spade or mattock, then several seed are dropped on the spot and covered to a depth of 1 or 2 inches with soil. This method is particularly suitable for fall sowing of the seed of the oaks, hickories, black walnut, and butternut.

BROADCAST SOWING.

The seed may be scattered broadcast over an area, either plowed or unplowed, in the same manner as wheat and oats are sown. This method is not recommended for any species, as it requires a large quantity of seed to the acre and is likely to be unsuccessful.

SEASON OF PLANTING OR SOWING.

In general, early spring planting is preferable to planting at any other season. As compared with fall planting, it has at least two

distinct advantages: The stock has a whole growing season in which to become established before it is subjected to the rigors of winter; and it is not in immediate danger of being heaved out of the ground by alternate freezing and thawing. If there is no great danger of the seeds being disturbed by rodents during the winter, fall is the preferable season for direct sowing of the seed of nut-bearing trees and of the oaks. When this danger exists, spring sowing is advisable.

SPACING OF TREES IN PLANTATION.

If timber is the primary object of a plantation, rather close spacing is advisable. This method produces trees with straight bodies and few branches, and hence of high lumber value. If the primary object

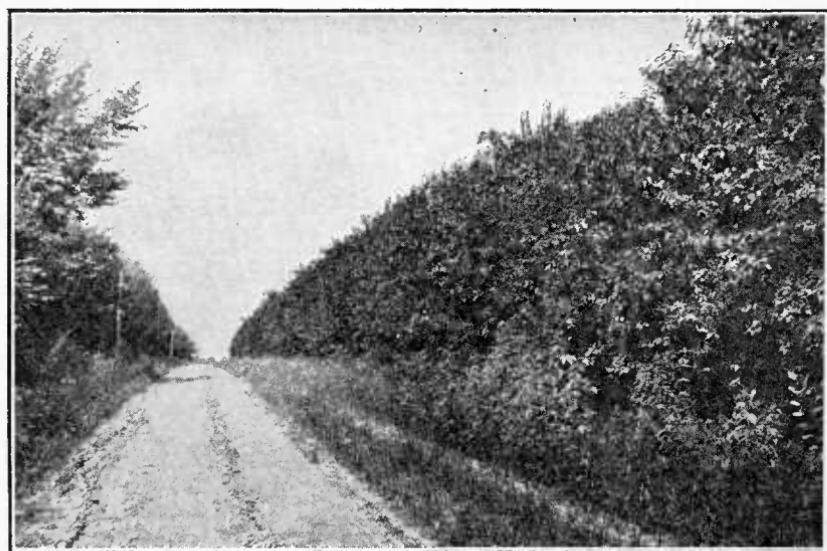


FIG. 6.—Osage orange windbreak, 12 years old. Monroe County, Iowa.

is protection, close spacing in the rows and wide spacing between them is best; for it will produce trees with some branches extending nearly to the ground, and hence will give the greatest protective efficiency. The actual spacing desirable for these two purposes depends upon the characteristics of the tree, upon the region, and upon the area or site to be planted. Trees which grow well in shade, such as hard maple and beech, may be planted more closely than those which require abundant light, such as cottonwood and yellow poplar. On situations which because of poor soil are unfavorable to tree growth, closer spacing is advisable than on more favorable situations. The greater number of trees to the acre will compensate for the higher mortality soon after they are set out, and, through the greater amount of shade furnished, will afford better protection to the soil. In regions of little rainfall there will not be sufficient moisture to support a dense

grove of trees. Accordingly, very close spacing can not be practiced there unless irrigation is possible.

The approximate spacing considered generally desirable for the more promising species is shown in Table 4. To meet a specific condition of soil or climate, some other spacing may be better. Before planting, it is advisable to write to the State forester concerning the matter.

TABLE 4.—*Spacing for forest trees.*

Kind of trees.	Spacing for woodlot.	Spacing for two-row wind-break.	Kind of trees.	Spacing for woodlot.	Spacing for two-row wind-break.
Green ash.....	Feet. 6 by 6	Feet. 4 by 8	Honey locust.....	Feet. 8 by 8	Feet.
White ash.....	6 by 6	.....	Hard or sugar maple.....	6 by 6	.....
Basswood.....	6 by 6	.....	Silver maple.....	6 by 8	4 by 8
Black birch.....	6 by 6	.....	Russian mulberry.....	.....	4 by 8
Yellow birch.....	6 by 6	.....	Red oak.....	6 by 6	.....
Bovelder.....	.....	4 by 8	White oak.....	6 by 6	.....
Hardy catalpa.....	7 by 7	.....	Osage orange.....	.....	2 by 8
Black cherry.....	6 by 6	.....	Red gum.....	8 by 8	.....
Cottonwood.....	10 by 10	4 by 10	Sycamore.....	8 by 8	.....
White elm.....	6 by 8	.....	Black walnut.....	6 by 8	.....
Eucalyptus (blue gum).....	10 by 10	4 by 10	Yellow poplar.....	10 by 10	.....
Hickory.....	6 by 6	.....	White willow.....	8 by 8	3 by 8
Black locust.....	6 by 6	.....	Yellow willow.....	8 by 8	3 by 8

Table 5 shows the number of trees required to the acre for the spacings given.

TABLE 5.—*Trees required to the acre with spacing indicated.*

Spacing in feet.....	10 by 10.	8 by 8.	6 by 8.	6 by 6.	4 by 8.	4 by 6 or 3 by 8.	4 by 4 or 2 by 8.
Number of trees required to the acre.	436	680	908	1,210	1,361	1,732	2,723

CARE OF PLANTATION.

CULTIVATION.

Though cultivation is not absolutely essential in all cases, particularly on loose soils in the regions where hardwoods thrive naturally, it is nearly always beneficial to a plantation, and especially so during the first several years of its existence. Cultivation is essential to success in regions of little rainfall where irrigation can not be practiced and on areas heavily sodded with grass. A heavy sod practically insures the failure of a young hardwood plantation. Horse cultivation is entirely practicable. If desired, some agricultural crop, such as potatoes, may be grown between the rows of trees during the early period of the plantation's growth. Cultivation should be given two or three times a year.

Forest trees are subject to damage by heavy frosts and, if they are growing vigorously when these frosts occur, they may be severely

injured. Late cultivation induces late growth; there should be no cultivation, therefore, after the middle of the growing season.

CLEANING AND LIBERATION CUTTINGS.

When a piece of cut-over land is planted, it may happen that the natural brushy growth present will for a few years outgrow the planted trees, overtop them, or crowd them so as to interfere seriously with their development. In such a case, it will be necessary, perhaps for two or three successive years, to lop off this brush with a knife, pruning shears, or other sharp instrument.

When there are old trees with wide-spreading crowns on areas to be planted, it will be desirable to remove these trees a few years

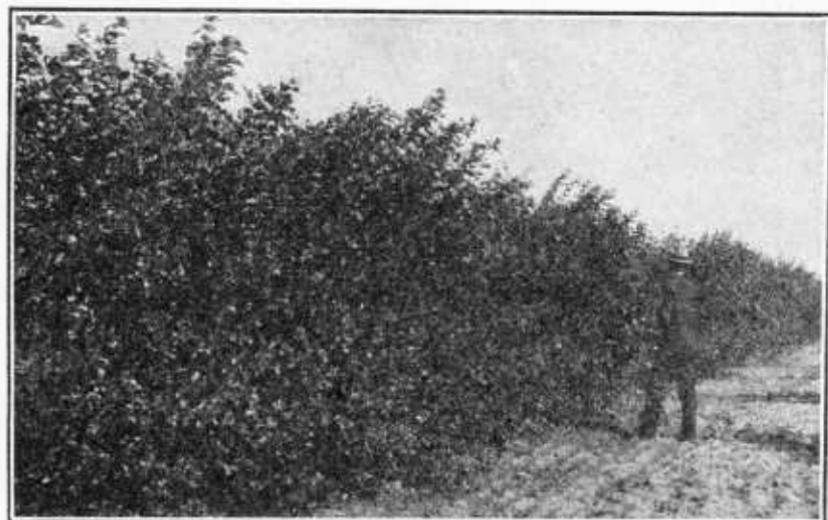


FIG. 7.—Russian mulberry windbreak, 5 years old. Graham County, Kans.

after the small trees are set out. Otherwise, because of the shade, the small trees will not develop satisfactorily.

THINNING.

To produce clean-bodied timber, close spacing is desirable. When the tops of the trees begin to intermingle and crowd each other, however, they become like an overcrowded stand of vegetables in a garden. Growth is stagnated. A good gardener would pull out a portion of the vegetables in a garden that had reached this condition. When trees have reached a similar condition some of them should be cut out. In both cases, the result is the best development of the remaining portion rather than a poor development of the original number. The best-formed, most valuable, and most healthy trees should be selected to remain, and the others that are likely to interfere with their growth should be removed.

Thinnings are usually necessary by the time a plantation reaches the age of 20 years, sometimes sooner. Thinning may be done at odd times by the owner of the plantation at no other cost than his labor. Care should be exercised that the openings in the crown



FIG. 8.—Cottonwood plantation, 12 years old. Trees 8 inches in diameter, 50 feet in height. Faribault County, Minn.

cover of the stand made by removing trees are no larger than may be closed in from three to five years by the growth of the remaining tree tops. When poles are cut for some farm use, a crude form of thinning may be secured by a little care in the selection of trees with a view to the betterment of the stand.

PRUNING.

Pruning of the branches of trees in a plantation is usually unnecessary and, because of the cost of the labor involved, undesirable. If spaced closely enough, most forest trees in plantations will prune



FIG. 9.—Blue gum (*Eucalyptus globulus*) plantation, 28 years old. Trees 14 inches in diameter.
Los Angeles, Calif.

themselves. Sometimes it will be profitable, in a stand that is intended to produce lumber, to prune the best trees by simply knocking off with an ax such dead and brittle limbs as can be reached.

Occasionally, dead branches of black walnut trees persist for a number of years, and they are likely to form loose knots. The same is true of catalpa, which, moreover, is subject to serious attack by a fungus around the base of these loose dead branches. Such branches of both species should be removed. If, because of wide spacing or for some other reason, the trees are assuming a poor timber form, it may be necessary to correct the condition by pruning.

If pruning is undertaken it should be conducted during late winter or early spring, and should not be overdone.

If a tree is pruned too far up, it may become top-heavy and be easily broken off by a severe wind. Catalpa, ash, and black cherry

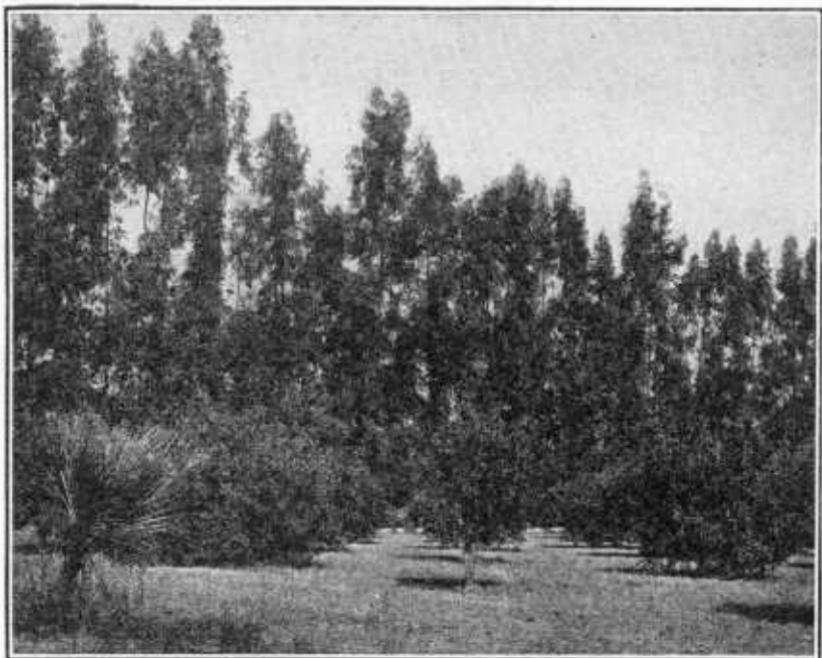


FIG. 10.—Blue gum (*Eucalyptus globulus*) windbreak, sheltering a lemon orchard. San Bernardino County, Calif.

in plantations are known to have suffered from this, and it seems likely that the same thing is true of many other species.

PROTECTION.

Plantations should be protected against fires and grazing. Fires will kill young trees and injure old ones. Live stock of all kinds should preferably be excluded from a plantation at all times and particularly when the trees are small. The animals almost invariably cause damage to the trees by nipping off the branches, peeling the bark, trampling the roots, or trampling the small trees themselves. If the shade of the trees is a necessity for the animals, they should

at least be restricted to a limited area of the plantation. In case the trees are being injured by insects, animals, or diseases, a remedy should be sought by inquiry of the United States Department of Agriculture or the State Agricultural College.

SOURCES OF PLANTING STOCK.

Private nurserymen are usually able to supply planting stock of the more important forest trees. The Forest Service will supply lists of these nurserymen upon request. In the following States forest tree nursery stock of some species for forest (not landscape) planting within the State may be obtained through the service indicated. In some States the distribution is limited to farmers.

Sources of forest tree stock.

Alabama.—Commission of Forestry, Montgomery.
California.—Department of Natural Resources, Division of Forestry, Sacramento.
Colorado.—State Board of Agriculture, Department of Forestry, Fort Collins.
Connecticut.—Connecticut Agricultural Experiment Station, New Haven.
Delaware.—State Forestry Department, Dover.
Florida.—Florida Board of Forestry, Tallahassee.
Georgia.—State Board of Forestry, State Capitol, Atlanta.
Hawaii.—Commission of Agriculture and Forestry, Honolulu.
Idaho.—University of Idaho, School of Forestry, Moscow.
Indiana.—Department of Conservation, Division of Forestry, Indianapolis.
Iowa.—Iowa State College, Ames.
Kansas.—Kansas State Agricultural College, Division of Forestry, Manhattan.
Kentucky.—Kentucky State Forest Service, Frankfort.
Louisiana.—Department of Conservation, Division of Forestry, New Orleans.
Maine.—Maine Forest Service, Augusta.
Maryland.—University of Maryland, Department of Forestry, 1411 Fidelity Building, Baltimore.
Massachusetts.—Department of Conservation, Division of Forestry, 20 Somerset Street, Boston.
Michigan.—Michigan State College of Agriculture, Forestry Department, East Lansing.
Michigan.—Department of Conservation, Lansing.
Mississippi.—State Forestry Commission, Jackson.
Montana.—State Forest Department, Missoula.
Nebraska.—College of Agriculture of the University of Nebraska, Extension Service, Lincoln.
New Hampshire.—State Forestry Commission, Concord.
New Jersey.—Department of Conservation and Development Division of Forests and Parks, Trenton.
New York.—Conservation Commission, Division of Lands and Forests, Albany.
North Carolina.—Department of Conservation and Development Division of Forestry, Raleigh.
North Dakota.—School of Forestry, Bottineau.
Ohio.—Agricultural Experiment Station, Department of Forestry, Wooster.
Oklahoma.—Oklahoma Forest Commission, Oklahoma City.
Oregon.—State Board of Forestry, Salem.
Pennsylvania.—Department of Forests and Waters, Harrisburg.
Porto Rico.—Department of Agriculture and Labor, Rio Piedras.
South Carolina.—State Forestry Commission, Columbia.
Tennessee.—Department of Agriculture, Division of Forestry, Nashville.
Utah.—Utah State Agricultural College, Extension Service, Logan.
Vermont.—State Forest Service, Montpelier.
Virginia.—State Conservation and Development Commission, Virginia Forest Service, University.
Washington.—State College of Washington, Agricultural Experiment Station, Pullman.
West Virginia.—Game, Fish, and Forestry Commission, Charleston.
Wisconsin.—State Conservation Commission, Madison.
Wyoming.—University of Wyoming, Experiment Station, Laramie.

SEED COLLECTION, EXTRACTION, AND STORAGE.

SEED COLLECTION.

Nearly any kind of tree seed can be bought from commercial seed houses, but often it may be cheaper and otherwise more advantageous to collect it near home. The collected seed will certainly be fresh, and the seedlings grown from it should be perfectly hardy so far as the climate is concerned.

TIME TO COLLECT.

Seed should be collected when ripe. For most kinds this means during autumn. Collecting may be extended into the winter for

such species as the ashes, catalpa, honey locust, sycamore, and any others that retain the seed on the trees until that time. A few kinds of seed ripen during the spring or summer and must, of course, be collected at that time. Seed of such species as willow and cottonwood, which scatters soon after ripening, must be gathered promptly. Seed which hangs on the tree for a considerable period, such as that of ash and sycamore, may be gathered more at leisure.

TABLE 6.—*Seed which ripens in spring or summer.*

Species.	Time of ripening. ¹
Elms (all species except cedar elm and southern red elm).....	March to June.
Silver maple.....	April, May.
Red maple.....	April to June.
River birch.....	May, June.
Willows.....	March to June.
Poplars.....	April to July.
Mulberry.....	June to August.
Cherries.....	June to September.
Plums.....	July to September.

¹ As indicated by the dates, the time of ripening for any one species varies in different regions. In the South the ripening may occur in March, while in the cooler northern regions it may be deferred until June.

WHERE TO COLLECT.

Middle-aged trees growing in the open, in fence corners, or along roadsides, and with broad-spreading crowns ordinarily produce seed in greater abundance than those growing in dense forests. Trees of this kind, when they are of vigorous growth, are among the best sources of seed. On areas where trees are being felled for lumber or other uses splendid opportunities are often afforded for seed collecting. When the trees are felled, seed borne in their tops is easily gathered.

HOW TO COLLECT.

Tree seed must necessarily be picked by hand. Seed of the oaks, hickories, walnut, beech, chestnut, often that of the locust, and sometimes that of other species, may be gathered from the ground. The seed of such trees as the ashes, cherries, cottonwood, willow, hackberries, sycamore, and basswood, which clings to the branches, is picked from the standing trees or from those felled in lumbering operations. Pruning shears on a long pole or a home-fashioned iron hook, sharpened on its inner edge and fastened to a long pole, may often be used to advantage in clipping the seed from standing trees. Sometimes, with the aid of a hook or a rope thrown over a branch, the seed may be pulled down within reach. Professional seed gatherers often climb the trees to reach the seed.

SEED EXTRACTION.

The fruit of some hardwood trees requires special treatment to separate the seed from the fleshy covering, pod, or hull.

The fruit of osage orange, mulberry, the cherries, cucumber, holly, black gum, Kentucky coffeetree, honey locust, and others of a fleshy nature, needs to be macerated in water until the seed can be washed out. It should then be dried in a cool, shady place.

The fruit of the black locust readily yields its seed if it is placed in a sack or on a smooth surface and lightly flailed.

When fairly dry, the hulls of the pignut, shellbark, shagbark, and the mockernut hickories will fall off in handling. The thin hulls of other hickories need not be removed. The soft hulls of black walnut may be removed by hand, by running the nuts through a close-set

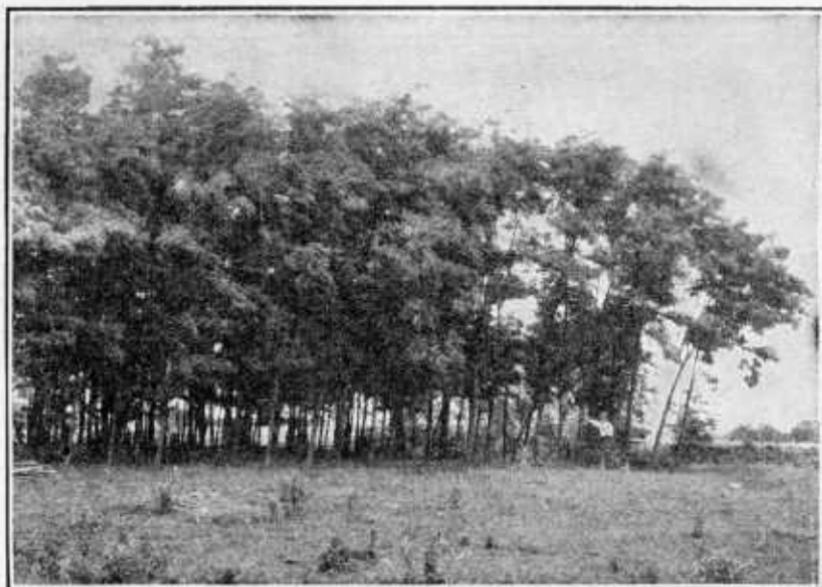


FIG. 11.—Black locust plantation, 9 years old. Trees 3 to 6 inches in diameter, 35 feet in height.
Knox County, Ind.

cornsheller, or by allowing the nuts to lie on the ground in a sheltered place until the hulls rot or are destroyed by a small maggot that often attacks them. This maggot does no harm to the nut itself.

SEED STORAGE.

The best time to sow seed, either in the nursery or on the permanent planting site, is soon after it is ripe. When this is not possible, the seed must be stored until spring. Seed that matures in the spring and early summer, that of the willows, poplars, most of the elms, river birch, and red and silver maples, does not retain its vitality well if stored. It should be sown as soon after ripening as possible. Most of the late-maturing hardwood seed may be successfully stored until the following spring.

The principal considerations regarding seed storage are that the seed must not be allowed to dry out excessively, because this impairs its power to germinate; and that it must not be kept at the same time moist and warm, because this induces premature germination, or molding and deterioration. Seed should not be stored in a warm place. Cold storage of some kind is essential.

COLD DRY STORAGE.

Some kinds of hardwood tree seed may be stored dry without deteriorating greatly, provided the temperature is constantly near the freezing point or lower. Among such is the seed of the catalpa,

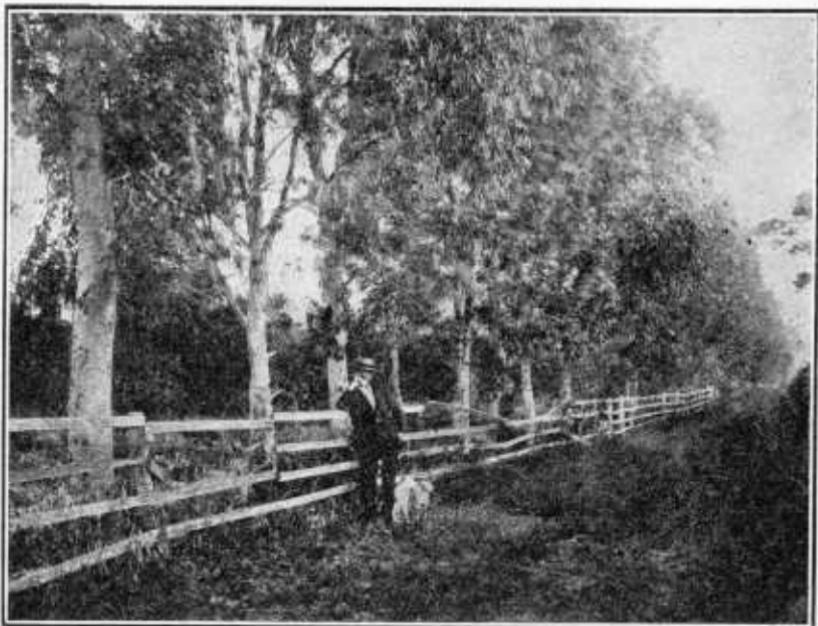


FIG. 12.—Red mahogany (*Eucalyptus resinifera*), 11 years old. Trees 14 to 18 inches in diameter, 60 to 65 feet in height. Brevard County, Fla.

honey locust, osage orange, and boxelder. After the seed coat is thoroughly dried by exposure to the air for a few days, the seed may be placed in sacks and hung up out of the reach of rats, mice, squirrels and chipmunks, in some outbuilding or in the attic where the temperature will remain low through the winter.

COLD MOIST STORAGE.

Cold moist storage is probably the most suitable for all kinds of hardwood tree seed, provided the temperature can be kept at the freezing point or lower. Even seed that can be stored dry will, if stored under cold moist conditions, germinate more quickly when sown. Cold moist storage is particularly well adapted for the seed

of walnut, oaks, hickories, chestnut, beech, basswood, sugar maple, and some other trees, the seed of which does not keep well if stored dry. If a large quantity of the nut seed is to be stored, it may simply be thrown on the ground after the advent of cold weather, in a layer 2 or 3 inches deep, and covered with sand, leaves, or forest litter, and then with a layer of dirt. The dirt should be rounded off so that water will not stand on it, and the whole pile may be covered with boards to prevent the soil from being washed away. It may be preferable to dig a shallow pit 6 inches or more in depth, in which to place the seed, and then use the same method of covering. In either case, the situation selected should be such that water will not collect and stand upon the pile.

When there is only a small quantity of seed, or when the seed itself is rather small, it may be stored in a box of moist sand. First, a layer of sand about 1 inch deep should be put in the box, then a layer of seed 1 inch thick, another layer of sand, and so on until the box is full. The box should be buried out of doors, at a depth of a foot or more, and covered with leaves and soil. A well-drained location



FIG. 13.—Lombardy poplar windbreak, 11 years old, 30 feet high.
Finney County, Kans.

should be chosen. In the spring the sand may be separated from the seed by screening. Very small seed, such as that of birch, may be placed loose in small cloth sacks and these alternated with layers of sand.

Seed stored in any one of these ways should be examined occasionally to see that it is not being disturbed by rats or mice. It must be watched very carefully in the spring, for, with the coming of warm weather, it is likely to germinate or to mold and heat. It must be sown either in the nursery or in the field at the very earliest possible opportunity after the frost is out of the ground in the spring.

Possibly the chief objection to both of these methods of storage out of doors is that most kinds of seed can be kept over only one winter, because with the coming of warm weather, the seed will begin to sprout. The seed of a few trees, however, such as the hawthorns, hollies, and black walnut, often does not germinate readily the next spring. This seed may be stored in moist sand in a cool place even until the second spring.

TABLE 7.—*Method of storage suitable for different kinds of tree seed.*

Cold and dry. ¹	Cold and moist.	Can not be stored; should be sown at once.
Birches.	Alder.	River birch.
Black locust.	Ashes.	Blue beech.
Boxelder.	Basswood.	Elms (except cedar elm and southern red elm).
Catalpa.	Beech.	Ironwood.
Black cherry.	Black gum.	Red maple.
Holly.	Black walnut.	Silver maple.
Honey locust.	Butternut.	Poplars.
Kentucky coffeetree.	Chestnut.	Willows.
Mulberry.	Cucumber.	
Osage orange.	Dogwood.	
	Cedar elm.	
	Southern red elm.	
	Hackberry.	
	Hawthorn.	
	Hickories.	
	Sugar maple.	
	Oaks.	
	Persimmon.	
	Red gum.	
	Sycamore.	
	Yellow poplar.	

¹ While the species listed in this column will withstand cold and dry storage, cold and moist storage would be preferable for most of them.

GROWING THE SEEDLINGS.

While some hardwood seedlings may be grown without great difficulty, the production of others, such as the eucalypts, should be left to the professional nurseryman. If a man's time and the actual expense connected with growing hardwood seedlings are considered, it may often be no cheaper to grow than to buy them. When home-grown, however, the seedlings are at hand when wanted, and this is a distinct advantage.

LOCATION OF SEED BEDS.

The seed beds should be located in good, well-drained, preferably loamy soil, in any convenient place. Proximity to woods or brushy areas should ordinarily be avoided, because these places harbor mice, chipmunks, or squirrels, which may disturb the seed. Proximity to the farm dwelling is desirable, because rodents are less likely to be abundant there.

PREPARATION OF SEED BEDS.

As with beds for vegetable crops, the soil should be spaded or plowed up and then well pulverized with harrow or rake. The smaller the seed to be sown the more thorough should be the prepara-

tion of the soil. Fall plowing, followed by spring spading and raking, will result in the soils being more mellow than if spring spading and raking only are practiced. Thorough preparation of the beds will result in better germination of the seed and better growth of the seedlings.

SOWING THE SEED.

METHOD.

Although in commercial operations the practice of broadcasting hardwood seed of many species is often followed, it is believed that in a small farm nursery it will ordinarily be more satisfactory to sow most kinds of seed in drills. These drills may be 2 or 3 feet apart to permit horse cultivation, or they may be spaced as closely as 10 or 12 inches. In the latter case, hand cultivation will be necessary. Those trees which may need shade (p. 27) should be grown in closely spaced rows. Less work and expense will then be entailed in providing the shade than is necessary when the rows are 2 or 3 feet apart.

The seeds should be sown at a depth equal to two or three times their own thickness and close enough in the drill so that from 12 to 15 seedlings to the linear foot will result. Ordinarily, the drill need not be more than half an inch wide. In some cases, however, a drill of that width will result in crowding the seed. This is true for the seed of yellow poplar, only a small proportion of which sprouts (see Table 7); for seed with large wings, such as that of maples, catalpa, and ashes; and for seed of large size, such as that of walnut, butternut, chestnut, and some of the oaks. In all such cases the drills should be 2 or 3 inches wide, or wider if necessary, so that the seed may be distributed in them without crowding.



FIG. 14.—Hardy catalpa plantation, 21 years old. Iowa County, Iowa.

With small or thin seed, such as that of birch, elm, or sycamore, the best results, perhaps, will be secured by sowing broadcast and rather thickly over the beds, pressing the seed into the loose soil by means of a board, and covering it very lightly with soil and a light mulch of leaves or straw. Nearly any seed may be broadcasted, if that is desired.

THE USE OF SPROUTED SEED.

Because of the long taproot formed by the nut-bearing trees, and the consequent loss that ordinarily attends the transplanting of seedlings to the field, an experiment conducted by the Pennsylvania Forest Commission is of interest. Seed of white oak, black walnut, butternut, hickory, and red ash was stored over winter and stratified thinly in the spring. After the seed began to germinate and the root had developed to a length of from 2 to 4 inches, from 1 to 2 inches of this was pinched off. When the seed was planted, a very fibrous, stocky root system developed, the usual long taproot being absent.

NUMBER OF SEED TO SOW.

The number of seed to sow per foot depends upon the percentage of germination. This varies considerably, but Table 8 shows approximately the proportion for different species.

TABLE 8.—*Number of seed to sow per running foot of row to secure 15 seedlings to the foot.*

Kind of tree.	Proportion of seed that will sprout.	Number of seed to sow to the root.	Kind of tree.	Proportion of seed that will sprout.	Number of seed to sow to the foot.
Yellow poplar.....	1/10	150	Honey locust.....	1/10	23
Sycamore.....	1/5	50	Oaks.....	1/10	23
Basswood.....	2/5	30	Beech.....	1/10	20
Maple.....	2/5	30	Black walnut.....	1/10	20
Mulberry.....	2/5	30	Butternut.....	1/10	20
Ash.....	2/5	25	Hardy catalpa.....	1/10	20
Boxelder.....	2/5	25	Black cherry.....	1/10	20
Kentucky coffee-tree.....	2/5	25	Chestnut.....	1/10	20
Red gum.....	2/5	25	Hackberry.....	1/10	20
Black locust.....	2/5	23	Hickory.....	1/10	20
Elm.....	1/4	23	Osage orange.....	1/10	20

In the case of yellow poplar, for instance, which has a germination of only 10 per cent, it would be necessary to sow 150 seeds to the foot to obtain 15 seedlings. Only 50 seeds to the foot would be necessary for sycamore, which has a germination of 30 per cent.

The number of seeds to the pound of the more important species is about as follows:

TABLE 9.—Approximate number of seed to the pound.¹

Kind of tree.	Number of seed to the pound.	Kind of tree.	Number of seed to the pound.
Arizona ash.....	13,000	Huckleberry.....	2,600
Blue ash.....	7,000	Bitternut hickory.....	110
Green ash.....	16,000	Mockernut hickory.....	110
White ash.....	6,000	Pignut hickory.....	200
Basswood.....	6,000	Shagbark hickory.....	90
Beech.....	1,400	Shellbark hickory.....	80
Black or sweet birch.....	488,000	Honey locust.....	3,000
Yellow birch.....	425,000	Kentucky coffee tree.....	230
Paper birch.....	700,000	Red maple.....	18,000
Black gum.....	2,800	Silver maple.....	2,400
Black locust.....	27,000	Sugar maple.....	7,200
Black walnut.....	25-35	Russian mulberry.....	200,000
Boxelder.....	14,500	Chestnut oak.....	180
Butternut.....	16-10	Pin oak.....	380
Hardy catalpa.....	19,500	Red oak.....	125
Black cherry.....	4,500	Scarlet oak.....	260
Chestnut.....	100-150	Swamp white oak.....	160
Cottonwood.....	1,350,000	White oak.....	210
Cucumber.....	3,000	Osage orange.....	12,500
Red elm.....	54,000	Red gum.....	175,000
White elm.....	94,000	Sycamore.....	170,000
Eucalyptus (blue gum).....	215,000	Yellow poplar.....	18,500

¹ Includes that portion of the fruit which is generally sown.

SEASON TO SOW.

Seed which ripens in the spring or early summer (see Table 1) should be sown at that time. That which ripens in the autumn may be sown then, or stored until spring. Fall sowing is in most regions preferable for all species, if the seed beds can be adequately protected against rodents. It is especially true for such seed as that of the chestnut or the white oaks, which may lose their vitality if stored over winter. Fall sowing should be deferred until just before cold weather sets in. If seed is sown early in the fall, and warm weather follows, the seed may sprout and later be killed by the cold of winter. Spring sowing should be done just as soon as the frost is out of the ground.

It is generally advisable to mulch fall-sown seed beds with 2 or 3 inches of forest leaves or litter. Straw may also be used. This mulch will prevent the rains from washing out the seed and will also prevent the ground from alternately freezing and thawing, and heaving out the seed. The mulch should be removed as soon as the seedlings begin to appear in the spring.

METHODS OF HASTENING THE GERMINATION OF SEED.

Seed coats which are nearly impermeable to water are often the cause of delay in sprouting. Fall sowing, or the cold moist storage of the seed over winter, gives a long period for absorbing moisture. The seed will then usually sprout promptly the following spring or summer. Sprouting is sometimes hastened by soaking the seed for several days in *cold* water. If stored dry and intended for sowing in the spring, the bony-coated seed of black locust, honey locust,

and Kentucky coffeetree, just before sowing, should be placed in water heated nearly to the boiling point. After the seed has swollen, it should be removed and sown at once. The operation should be repeated for the seed which does not swell on the first immersion.



FIG. 15.—Black walnut plantation. Indiana.

LENGTH OF TIME REQUIRED FOR SPROUTING.

Some seeds sprout in a few days, others not for several weeks, and still others often not until the second season, particularly if they are stored dry over winter and then sown in the spring. Among

those which are likely to lie over for a year are basswood, holly, black locust, Kentucky coffeetree, and honey locust. If stored dry and sown in the spring, a portion of the seed of some trees may sprout the first year and an additional portion the following year. Among these are hackberry, blue beech, ironwood, cucumber, black walnut, beech, osage orange, black cherry, white ash, boxelder, cucumber tree, yellow poplar, sycamore, and sugar maple.

CARE OF SEED BEDS.

WATERING.

If water is available and can easily be applied, it is advisable to keep the seed beds moist until the seeds sprout, and later to water the seedlings when the beds become dry. It will usually be unnecessary to water seed sown in the fall. Such seed will absorb moisture during the winter and with the coming of warm spring weather will sprout quickly. Watering of the seedlings should be discontinued after midsummer, in order that they may harden up properly before the fall frosts.

PROTECTION.

Seed beds must, of course, be protected against live stock and sometimes against field mice or other rodents. Two or three house cats usually afford some protection against the latter, but sometimes resort must be had to small traps. If birds become troublesome they must be scared away or shot.

SHADING.

Seedlings of most hardwood trees will need no shade in the seed beds; but those of the beech, birch, red gum, white ash, sugar maple, slippery or red elm, hackberry, and mulberry, are likely to be damaged by intense sunlight, and, when this appears to be the case, should be supplied with partial shade. A covering of brush or tree branches in leaf will usually be sufficient. If this is lacking, shade frames of some kind that will cut off about half of the sunlight from the seedlings should be constructed. Some nurserymen use shade frames made by nailing lath spaced about $1\frac{1}{2}$ inches apart on a rectangular frame. The growing of such seedlings under somewhat open woods should prove successful.

WEEDING AND CULTIVATION.

The beds should be weeded and cultivated several times during the growing season. Horse cultivation may be practiced where the rows are spaced widely. In beds seeded broadcast cultivation is, of course, impracticable.

REMOVING SEEDLINGS FROM SEED BEDS.

Hardwood seedlings 10 inches or more in height are large enough for field planting. Most of them reach this size in one growing

season. Some, including the seedlings of black cherry, cucumber tree, yellow poplar, basswood, sugar maple, red gum, black gum, red mulberry, birch, and beech, may have to remain in the seed beds two years or more. In digging them from a farm nursery the spade is the most effective tool. Care should be taken to injure the roots as little as possible, and to secure practically all of them. Injured portions of the roots should be cut off with a sharp knife. The seedlings should not be dug until the time for planting them in their permanent locations. Digging them and exposing the roots to the air for some time may kill them. Even when they are being transported to the planting site, the roots should be covered with wet burlap, wet straw, moss, or other similar material.

SOURCES OF INFORMATION AND ADVICE FOR THE PLANTER.

Many of the States now have forestry departments. A few have forest extension specialists. The men connected with the work are familiar with local conditions, and are able and willing to answer inquiries concerning planting or other forestry problems from people residing in the State. In some cases they can arrange to visit a farm and give advice on the ground. The addresses of these forestry departments or officers follow:

Sources of information concerning tree planting.

- Alabama.—State Forester, Montgomery.
- California.—State Forester, Sacramento.
- Colorado.—State Forester, Fort Collins.
- Connecticut.—State Forester, Hartford.
- Connecticut.—Forester, State Agricultural Experiment Station, New Haven.
- Delaware.—State Forester, Dover.
- Florida.—State Forester, Tallahassee.
- Georgia.—State Forester, State Capitol, Atlanta.
- Hawaii.—Territorial Forester, Honolulu.
- Idaho.—School of Forestry, Moscow.
- Indiana.—State Forester, Indianapolis.
- Iowa.—Forestry Department, Iowa State College of Agriculture, Ames.
- Kansas.—State Forester, Manhattan.
- Kentucky.—State Forester, Frankfort.
- Louisiana.—State Forester, New Orleans.
- Maine.—Forest Commissioner, Augusta.
- Maryland.—State Forester, 1411 Fidelity Building, Baltimore.
- Massachusetts.—State Forester, 20 Somerset Street, Boston.
- Michigan.—State Forester, Lansing.
- Michigan.—Forestry Department, Michigan Agricultural College, East Lansing.
- Mississippi.—State Forester, Jackson.
- Minnesota.—State Forester, St. Paul.
- Montana.—State Forester, Missoula.
- Nebraska.—Extension Forester, College of Agriculture, Lincoln.
- New Hampshire.—State Forester, Concord.
- New Jersey.—State Forester, Trenton.
- New York.—Superintendent of Lands and Forests, Conservation Commission, Albany.
- North Carolina.—State Forester, Raleigh.
- North Dakota.—State Forester, Agricultural College, Bottineau.
- Ohio.—State Forester, Wooster.
- Oklahoma.—State Forester, Oklahoma City.
- Oregon.—State Forester, Salem.
- Pennsylvania.—Secretary, Department of Forests and Waters, Harrisburg.
- Porto Rico.—Insular Forester, Rio Piedras.
- Rhode Island.—Chief, Bureau of Forestry, Providence.
- South Carolina.—State Forester, Columbia.
- South Dakota.—Director of Extension, State Agricultural College, Brookings.
- Tennessee.—State Forester, Nashville.
- Texas.—State Forester, College Station.
- Utah.—Director of Extension, State Agricultural College, Logan.
- Vermont.—Commissioner of Forestry, Montpelier.
- Virginia.—State Forester, University.
- Washington.—Director, Agricultural Experiment Station, Pullman.
- West Virginia.—Chief Forester, Charleston.
- Wisconsin.—Superintendent, Forests and Parks, Madison.
- Wyoming.—Director, State Experimental Farm, Laramie.